

streamers and light extended from east and west through the zenith. At Detroit, Mich., three arches were seen at altitudes of 45°, 65° and 90°; also a corona near the zenith, and streamers and light 10° south of zenith; the three arches were continually moving upward or southward and back again, reaching sometimes 15° south of zenith. At Adrian, Mich., two arches first appeared, then a third one at or south of zenith from E. to W.; similar phenomena was seen throughout Mich. In Connecticut streamers flashed near to the zenith. In Illinois and Indiana observers generally report no true arch, but only waves, clouds, and streamers of light. At Gardiner, Me., a beam from east to west reached the zenith. New Jersey two arches seen, the second indefinite and within the first. Central New York arches from east to west through the zenith, and two or three others lower down towards the north; a fine corona was observed at Cazenovia, North Volney, Oneida and North Argyle; at New York city the altitudes of the arches were 45°, with streamers to the zenith. In Ohio telegraph lines were affected with ground currents, and one, and sometimes two perfect arches were observed, with streamers reaching to 75° altitude. Vermont, one of the most brilliant ever seen; corona was seen at Newport. Wisconsin, corona was seen at Manitowoc, Neillsville, and Rocky Run. The electric disturbance on telegraph wires was sufficient to interrupt the ordinary business between New York, Buffalo, Baltimore, Montreal and Washington.

OPTICAL PHENOMENA.

Solar Halos.—1st, Ind., N. J., N. Y.; 2nd, Ill., Ind., Iowa, Minn., Ohio, Wis.; 3rd, Del., Md., N. J., N. M., Ohio, Penn., Va., Vt.; 4th, Ga., Iowa, Me., Neb., N. H., Ohio, S. C.; 5th, Ind., Iowa, Mass., N. J., N. Y., Ohio, R. I., Wis.; 6th, Cal., Conn., Me., Mass., N. H., N. Y.; 7th, Minn., N. J., N. M., Wy.; 8th, Conn., Iowa, Mass., Mich., Neb., N. H., Ohio, R. I.; 9th, N. Y.; 10th, Ala., Fla., Ill., Kan., Ky., Miss., N. Y.; 11th, Iowa, N. Y., Wis.; 12th, Conn., Ind., Iowa, Mass., N. Y., Ohio, R. I., Wis.; 13th, Ind., Me., N. J., Ohio, Wy.; 14th, Ala., Ind., Ky.; 15th, Ala., Dak., Ind., Iowa, La., N. Y., Ohio; 16th, Fla., Ind., Iowa, N. Y., Tenn., Wis.; 17th, Ga., Ill., Ind., Mass., N. J., N. Y., Ohio; 18th, Conn., Ill., Ind., Miss., N. Y., Ohio, S. C., Wis.; 19th, Conn., Fla., Ga., Ill., Ind., Mich., N. H., N. Y., Ohio, Wis.; 20th, Conn., Ill., N. J., R. I.; 21st, Me., N. H.; 22nd, Ill.; 23rd, Texas; 24th, Ala.; 25th, Neb.; 26th, N. H.; 28th, Conn., Ill., Me., Mich., Wis.; 29th, Neb.; 30th, Ill.; 31st, Conn., Mass., N. Y., R. I.

Lunar Halos.—2nd, Iowa, Mo.; 5th, N. Y.; 14th, Ind.; 15th, Iowa, Mich., N. J., Penn.; 16th, Ind., Ky., N. J., Ohio; 17th, Conn., Ga., Ill., Ind., Iowa, Me., Mass., N. J., N. C., Texas, Wis.; 18th, Ala., Ill., Ind., Iowa, La., Mich., Mo., N. J., N. Y., Tenn., Wis.; 19th, Del., Ind., Me., Mich., Minn., N. J., N. Y., Ohio, Penn., Texas, Utah, Va.; 20th, Miss., Mo., N. J., N. Y., Va.; 21st, Cal., Mich., Mo., Texas; 22nd, Kan., Mo., Neb., Texas, Va.; 23rd, Iowa, Mo., Texas; 24th, Ala., Mo.; 25th, Minn.; 27th, Ga., Iowa; 28th, Fla.; 29th and 30th, La.

Mirage.—Tybee Island, Ga., 1st, 8th; Duluth, Minn., 8th, 23rd, 24th; New Bedford, Mass., 25th; Barnegat, N. J., 31st.

Scintillation of Stars.—No observations of scintillation have been received for May.

MISCELLANEOUS PHENOMENA.

Zoological.—Botanical.—The blooming and ripening of fruits only have been reported: *Apple* in bloom on the 5th in Conn.; 19th, Ga.; 7th and 13th, Ill.; 7th, 13th and 17th, Iowa; 19th and 31st, Me.; 16th, 17th and 21st, Mass.; 13th, Mo.; 2nd, Neb.; 4th, N. J.; 15th, N. H.; 21st and 30th, N. Y.; 6th, 7th, 8th, 13th, 14th and 15th, Ohio; 14th and 22nd, Penn.; 19th, Vt.; 18th, Wis. *Asparagus* ripe, 1st, Mass. *Cherry* in bloom, 1st, 7th, 11th, 12th and 13th, Mass.; 4th, Conn.; 14th, 15th and 18th, N. Y.; 1st, Ohio; 8th, Penn.; 16th, Vt.; ripe, 22nd, Miss. *Currants* in bloom, 6th, Mass. *Peach* in bloom, 6th, Conn.; 3rd and 13th, Mass.; 19th, N. Y.; 2nd, 11th and 15th, Ohio; ripe, 30th, Texas. *Pear* in bloom, 4th, Ill.; 16th, Me.; 10th, 13th, 14th and 17th, Mass.; 17th, N. H.; 18th, 19th and 21st, N. Y.; 9th and 18th, Penn. *Plum* in bloom, 18th, Ill.; 11th and 13th, Iowa; 3rd and 13th, Mass.; 19th, N. Y.; 18th, Penn.; 15th and 18th, Vt.; 12th, Wis. Ripe, 22nd, Miss. *Quince* in bloom, 26th, Mass.; 9th, N. J.; 18th, Ohio; 19th, Penn. *Blackberries* in bloom, 20th, N. J. Ripe, 10th, Texas. *Almond* in bloom, 2nd, Neb. *Strawberries* in bloom, 1st, N. J.

BIRDS.—The first arrival and their migrations are reported as follows: *Blackbirds*, 3d, Kans. *Blue-jays*, 5th, Kans. *Bobolinks*, 18th, Iowa; 15th, Me.; 13th and 15th, Mass.; 14th, N. Y. *Cuckoos*, 19th, N. J. *Ducks*, 30th, Dak.; 19th, Mass., NW., and 22d, NE. *Geese*, 3d, 4th, 5th and 6th, Neb., N.; 15th, Minn., N. *Kingbirds*, 7th, Neb.; 12th, Ohio. *Martins*, 2d, Wis. *Night Hawks*, 16th, Iowa. *Orioles*, 1st, Me.; 10th and 14th, Mass.; 12th, Neb.; 12th and 15th, N. Y.; 12th, Ohio; 14th, Vt.; 17th, N. J. *Robbins*, with young, 15th, N. Y. *Swallows*, 7th, Me.; 6th, Mass.; 9th, Neb.; 1st, 14th and 16th, N. Y.; 3d, Ohio; 8th, Utah; 6th and 7th, Vt.; 14th, Virg. *Yellowbirds*, 8th and 10th, Mass.; 17th, N. Y. *Whippoorwills*, 19th, Iowa; 14th, Mass.; 1st, Ohio.

INSECTS.—*Grasshoppers*, flying at Camp Sheridan, Neb., N., 28th, NE., 29th; 2nd, still hatching out at

Cresswell, Kan., and at Corning, Mo.; 1st to 22nd, hatching out at Clear Creek, Neb.; at Howard, Neb., have hatched out during month, and, although heavy rains have destroyed many, they are still damaging crops; 27th, at Melissa, Tex., brought thither by W. winds; left same at noonday; Mesquite, Tex., (no date) damaging crops; 14th, Ft. Gibson, I. T., disappeared, drowned out by heavy rains; 29th, North Platte, flying N.; Omaha, injured by cold rains; many destroyed by the farmers; injuring crops somewhat; 28th, coming out of the ground at South Orange, N. J., 30th, appeared at Ardenia, N. Y.; 7th, 8th and 9th at Boerne, Tex., flying N., large swarm; 10th, all gone; 12th to 25th, Griffin, Tex., flying N., no damage done; Denison, Tex., hatched out rapidly the first three days in April; April 23rd, began moving and destroying; May 15th commenced flying northward, with southerly winds, their numbers steadily decreasing until the 26th, when they disappeared. *Colorado Beetles*.—Destroying potato crop at Milford, Ind.; doing much damage at Litchfield, Mich.; destructive at Auburn, N. H.; 16th, South Orange, N. J.; 6th, Starkey, N. Y., 13th, Morgantown, W. Va.; 20th, Flushing, N. Y.

FISHES.—*Sturgeon*, 3rd, Lower Brule Agency, caught in Missouri river.

Polar Bands.—Neb., Plattsmouth, 1st. Ohio, Carthagena, 2nd, 3rd, 12th, 13th, 18th, 23rd and 30th. Iowa, Monticello, 2nd; Guttenberg, 3rd and 25th; Iowa City, 4th, 10th, 26th to 31st; Nora Springs, 28th. Minn., Duluth, 3rd. Me., Eastport, 10th. Ky., Louisville, 17th and 31st. Ga., Tybee Island, 17th. La., Point Pleasant, 18th. N. H., Auburn, 23rd. N. Y., Waterburgh, 27th. Ill., Elmira, 28th. Va., Wytheville, 30th and 31st.

Sunsets.—The characteristics of the sky, as indicative of approaching fair or foul weather, have been observed daily at sunset at all Signal Service stations. The monthly means from 100 stations show that 74 doubtful cases, or blanks, were recorded, and that out of the remaining 2,712 casts, 2,158, or 79.5 per cent., have been followed by the expected weather.

Prarie and Forest Fires.—Near Wytheville, W. Va., 1st, 2nd; Oregon, Mo., 1st, 4th; Monticello, Iowa, 4th; Clear Creek, Neb., 4th, 9th; Brookhaven, N. Y., 7th; Wuppinger's Falls, N. Y., 7th, 12th, 13th, 14th; Omaha, Neb., 8th, 9th; Marquette, Mich., 9th, 11th, 29th; Burlington, Vt., 11th; Eastport, 11th, 12th, 15th, 16th; Duluth, Minn., 12th; Grand Rapids, Mich., 13th; in northern New York, 12th to end of month; Alpena, Mich., and in New Brunswick, 14th; Portland, Me., 14th, 15th, 16th; Springfield, Mass., White Mountains, N. H., and Nile, N. Y., 15th; Mt. Desert, Me., and Adirondack Mountains, 16th; Fall River, Mass., 17th; Escanaba, Mich., 17th, 23rd, (town in great danger,) 29th, 31st; Portsmouth, N. C., 20th; 31st, for several days extensive forest fires have been raging in Marquette, St. Clair and Lapceur counties, Mich., and the towns of Oquata, Schoolcraft county, and Greenwood, Ogemaw county, were entirely destroyed.

Meteors.—1st, North Volney, N. Y.; Jacksonburg, Ohio. 5th, Stockton, Tex. 10th, Jacksonburg, Ohio. 11th, Tybee Island; Lyndon, Ill.; Wilmington, N. C. 12th, Tybee Island; Salem, N. J. 17th, Breckenridge. 20th, Jacksonburg, Ohio. 21st, Leavenworth. 22nd, Oregon, Mo.; Embarrass, Wis. 25th, Starkey, N. Y. 27th, Woodstock, Md. 28th, Woodstock, Md.; Carthagena, Ohio. 29th, Monticello, Iowa.

Zodiacal light was observed as follows: Southington, Conn., 3rd, 4th, 6th, 7th and 12th; Monticello Iowa, 1st, 4th, 5th, 6th, 7th, 8th, 10th, 11th; Cambridge, Mass., 8th; Adrian, Mich., 3rd, 6th, 11th; Atco, N. J., 4th, 12th, 13th, 14th; Waterburgh, N. Y., 4th, 6th; Wytheville, Va., 1st, 9th, 10th; Savannah, Ga., 1st, 2nd, 3rd, 5th, 7th, 8th, 9th, 10th, 11th, 13th, 14th, 15th, 16th, 29th, 30th, 31st; Tybee Island, Ga., 12th, 14th, 31st.

Earthquakes have been reported as follows: On the 2nd, Oshawa, Canada West, at 10:20 p. m.; shock lasting 10 seconds. 9th, at 8:30 p. m., several shocks, lasting 5 minutes, on the coasts of Peru, Bolivia and Chili. 10th, earthquake waves on the Sandwich Islands and the California coast. 15th, Port Stanley, Ontario, in the morning, a wave 5 feet high, probably due to some earthquake shock, suddenly swept along the northern shore of Lake Erie, followed for an hour by smaller ones. 25th, earthquake shock Knoxville, Tenn. 26th, 3 p. m., earthquake shock, New Harmony, Ind.

Concerning the earthquake of the evening of the 9th on the southern coast of Peru, and the accompanying destructive wave which spread over a great part of the Pacific ocean, the reports that have been received are, in brief, to the following effect: About 8:30 p. m. several very heavy, destructive earthquake shocks occurred within four or five minutes throughout the region from Arica (lat. 18.°4' S.) to Mexillones, at the southern extremity of Bolivia, and apparently proceeding from a central region near the boundary between Peru and Bolivia, or near the volcano Llago, (Laguna? or Argua?) The shocks were felt with less severity at Antofagasta, (possibly the town of that name in the Argentine Confederacy, lat. 26½° S., lon. 67½°) and also throughout Chili and northern Peru. The shock was immediately followed by a great ocean wave, which began by a recession of the sea from the shore; this recession seems to have been going on during the continuance of the shocks. Within a few minutes after the last severe shock, and in some cases while fire-engines were being placed near the sea shore to obtain water for extinguishing the fires, the great wave suddenly dashed up over the shore, destroying everything within its reach. Among the detailed

reports that have been received are the following: Beginning at the central region, at the mouth of the river Lon, (lat. 21.5° S., lon. 22.5° W.,) we have, first, Cobija, (lat. 22.5° S.,) three-fourths of the town destroyed; wave 35 ft. high. Topopilla, town obliterated. Mexillones, (lat. 23.1° S.,) town two-thirds obliterated; wave 65 ft. high. Coquimbo, (lat. 29.9° S.,) light shocks. Going northward we have, first, Peñon de Pica, or Chavanzgo, (lat. 21.2° S.,) town obliterated by the shock, fire and the water; many vessels injured in the harbor; the sea continued greatly agitated all night. Huanillos, town obliterated; wave nearly 60 ft. high. Iquique, (lat. 20.2° S.,) shock about 8:30 p. m., exact interval from first to last 4 m. 20 sec., all proceeding from the southeast, and with great regularity; the whole town shaken down, burned with fire or washed away; the recession of the sea occurred, and the first great wave came in several minutes, possibly 10 minutes, after the first shock. Arica, (lat. 18.4° S.,) very numerous shocks, destroying all the fine buildings, followed by a recession of the sea, and then 8 successive waves, from 10 to 15 feet in height. Ilo, (lat. 1.6° S.,) partly destroyed by ocean wave. Callao, (12° S., long. 77.1° W.,) the first ocean wave felt at 11 p. m.; several distinct rises and falls were felt during the night; the highest rise, about 8 feet, occurred at 4 a. m., 10th. Anaheim, Cal., (lat. 33.8° N.,) ocean wave rose 12 feet in a few minutes. Gaviota, Cal., (lat. 34.4° N., long. 120.1° ,) water rose and fell 12 feet three times in succession, between 7h. 10m. and 7h. 30m. a. m. San Francisco, (37.5° N., long. 122.5° ,) first earthquake wave began 6h. 18m.; maximum wave of 14 inches rise and fall at 8h. 20m. a. m., with maxima one hour apart; five rises and falls of 9 inches occurred in 8 minutes, superposed upon the larger wave. Sandwich Islands, throughout these islands the waves were large and sometimes destructive. The time of the first wave is well fixed for Honolulu as 4h. 45m. a. m., at which time the tide ran out and returned in 12 minutes; in this time the observers at Oahu and Maui agree. At Hilo, further southeastward, the observer says the ebb began at 4 a. m., and the wave swept in at 5 a. m., and others kept coming in all day; at 7 a. m., a wave was timed and found to occupy 4 min. in going through an extreme rise and fall of 14 ft.; in the afternoon three successive waves were timed and the average gave for each, 20 min. in passing through its rise and fall of 10½ ft. The heights of the waves at the different islands are as follows: On Hawaii, 5 ft. at Kawaihie; 30 ft. at Kealahakua; 36 ft. at Hilo. On Maui, 6 to 12 ft. at Makee and Mamalua; 12 ft. at Lahaina; 22 ft. Kahului. On Oahu, 4 ft. 10 in. at Honolulu. On Kanah, 3 ft. at Naivaiiwi. The volcano of Kilauea had exhibited unusual activity during the previous two weeks.

The following table gives the means of estimating approximately the velocity of the earthquake sea-wave in its passage over the Pacific Ocean:

Station.	Longitude.	Difference in time.	Arrival of Wave.		Interval.	Great circle distance.	Average velocity, hourly.
			Local time.	Normal time.			
Origen.....	70.3° W	0.0	h. m.	h.	h.	°	°
Callao.....	77.1	0.5	8 30 p. m.	8.5	0.0	0.0	
Gaviota.....	120.1	3.3	{ First, 11 0 p. m.	11.5	3.0	11.5	{ 3.8 }
San Francisco.....	122.5	3.5	{ Max., 4 10 a. m.	16.5	8.0	76.0	{ 1.4 }
Honolulu.....	157.9	5.8	7h. 10m. to 90 a. m.	22.6	14.1	73.8	{ 5.2 }
			{ First, 6 18 a. m.	21.8	13.3	76.0	{ 5.8 }
			{ Max., 8 20	24.1	15.6	76.0	{ 4.9 }
			{ First, 4 45 a. m.	22.6	14.1	96.0	{ 6.8 }

NOTES AND EXTRACTS.

Mr. S. W. Holman, of Boston, communicates to the Philosophical Magazine the results, as regards the air, of a new method of studying the relation between the viscosity and temperature of gases. As a result of his first experiments he says, it would appear that the viscosity of air increases proportionally to the 0.77 power nearly of the absolute temperature expressed in Centigrade degrees between the temperatures 32° and 212° Fahrenheit.

Mr. F. Guthrie describes a mercurial barometer of great sensitiveness, concerning which he states that the models he has made appear to succeed well. It consists of an ordinary vertical barometer tube, connected by a flat, horizontal, spiral tube of much smaller diameter, with a second short, open tube, corresponding to the short leg of a syphon barometer. A small bubble of air is visible in the spiral tube, dividing the mercury into two portions; the movement of this bubble is more rapid than the movement of the top of the mercurial column in the proportion of the area of the vertical and spiral tubes.

Observations on the relation between the weather and the twinkling of stars have been made for a number of years by Montigny in Belgium, and, as the result of observations on 230 evenings, with his scintillometer, he finds that the scintillations increase on the approach of a storm, especially of rain.

The direct use of the heat of the sun, instead of its indirect use, as a motive power continues to attract